July 12, 2002

Richard Batiuk
Associate Director for Science
U.S. Environmental Protection Agency
Chesapeake Bay Program Office
410 Severn Avenue, Suite 109
Annapolis, Maryland 21403

Dear Rich,

Enclosed is the STAC scientific review of the Bay Program's *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Tidal Tributaries* (DRAFT). The document was reviewed by 10 scientists with four from institutions from outside the Bay watershed.

The charge to STAC was to organize a scientific peer review of the report focusing on Appendix A (Designated Uses); Chapters 3-5 on criteria for Dissolved Oxygen, Water Clarity and Chlorophyll, respectively; and Chapter 6 (Implementation Guidelines). Each reviewer was asked to comment on Appendix A, Chapter 6, and one of the criteria chapters.

General comments from the reviewers.
The reviewers were impressed with the amount of work and detail that went into the criteria development. The Bay Program efforts will certainly extend beyond the Chesapeake Bay. There was agreement on the EPA's approach to have different DO criteria for different parts of the Bay rather than a single value. Likewise the reviewers felt the development of water clarity criteria for SAV was a very positive step forward. The adaptation of five designated uses is well supported and appropriate for a complex system such as the Chesapeake Bay. For the DO and water clarity criteria, there were no obvious deficiencies in the procedures and most of the comments centered on clarification of methodologies and extensive editing to make the document more readable and brief. All reviewers had editorial comments that would significantly improve the clarity of the document and should be considered in future drafts. It is strongly recommended that the Bay Program review these comments within the individual reports that will be mailed next week.

The criterion for chlorophyll *a*, however, was problematic with all three reviewers expressing concern about the methodologies and interpretation. Given the unanimity,

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STAC recommends that the chlorophyll *a* section be revised. Suggestions are listed at the end of the Chapter 5 comments below.

In summary, the DO and water clarity criteria were favorably received. However, there was substantial concern over the chlorophyll *a* criterion and revision is strongly recommended in future drafts. STAC requests that the Bay Program respond to each of the comments below and explain whether it will implement them and provide corresponding line and page number in the document. It is the Bay Program's prerogative not to use a recommendation, but the STAC membership respectively requests an explanation for any comment not executed.

Thank you again for allowing STAC to review the draft document for scientific content. Please feel free to contact STAC if you need clarification. We all hope it will lead to a regional as well as national resource for U.S. coastal waters.

Best Regards,

Jonathan Phinney
STAC Executive Board Member

Kevin Sellner
STAC Executive Officer/CRC Director

The following reviewers provided written comments:

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Specific Comments of Criteria Development for Chapters III-VI and Appendix A

Chapter III *Dissolved Oxygen Criterion*

1. A larval recruitment model is referenced throughout the text (e.g., page 31) and is an integral part of the DO criterion development. However, there is little background to assess it. At the very least, a summary of the salient features and structure is needed.
2. The dissolved oxygen tolerances used to develop the criterion are from studies conducted at low temperatures (< 20 degrees Celsius and in several cases at 10 degrees) (Appendix C). Low dissolved oxygen levels in the Chesapeake Bay occur at higher temperatures (> 20 C and mostly at > 25 C). Needed are results from experiments at higher temperature to better substantiate the criterion. These results may not exist, but this temperature discrepancy should be pointed out lest its omission overwhelms other more important sections.
3. The DO criterion of 1 mg l^{-1} in the deep channel is probably feasible, but it is unlikely to produce a "fully protected" environment. Hagy (2001) analyzed benthic fauna distributions in environments of 2.3 mg l^{-1}, and his paper should be consulted to better define "fully protected".
4. A DO criterion in the deep channel of 2 mg l^{-1} versus 1 mg l^{-1} would limit the release of phosphorus and nitrogen from the sediment and improve the water quality substantially. This point should be emphasized more even if the Bay Program feels that a 2 mg l^{-1} goal cannot be achieved.
5. Specific instructions on how the DO criterion will be verified are needed. Given that the water quality monitoring program collects monthly water samples, the exposure levels listed, such as 7-day mean and 30-40 day exposure levels, are not likely to be verifiable. Instantaneous criteria may be the most workable method.
6. Figures III-3 through III-7 are critical to developing DO criterion yet there is not enough documentation on how to read the figures or the rationale for selecting a particular DO value. For example, does Figure III-4 demonstrate that a DO value of 3.5 mg l^{-1} for 10 days is protective of migratory fish larvae? Is that an acceptable criterion? Similarly, Figure III-7 demonstrates that an instantaneous minimum above 1.4 mg l^{-1} is protective. But why choose 1.7 mg l^{-1} as the criterion and not a higher value? If 1.7 mg l^{-1} is more realistic from the Bay Program's point of view, then it should be explained.

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Chapter IV *Water Clarity Criterion*

1. Figure IV-1 (Conceptual Model of Light/Nutrient Effects on SAV Habitat) lists color as a variable for light attenuation in the water column, but is not discussed in the text. Other estuary programs do include color and the Bay Program needs to discuss its absence in their criteria.
2. The water clarity criteria are developed based on existing SAV beds. Are these criteria also protective of emerging or newly established SAV beds?
3. Chlorophyll *a* is an important factor in water clarity yet it is mentioned only three times in this chapter and never with a numeric criterion. Better coordination between the water clarity and chlorophyll *a* criteria sections is needed.
4. Were there any cost benefit or feasibility analyses done? Can state governments afford to implement the methodologies or develop the expertise? The data needs for spectral analysis alone are extensive and the states may not be able to afford them.

Chapter V *Chlorophyll a Criterion*

1. Mathematically derived chlorophyll *a* concentration that inhibits zooplankton is over-stated and not substantiated. High mesozooplankton abundance means that growth exceeds loss. Low mesozooplankton numbers means loss is greater than growth and the loss can come from either high fish and jellyfish grazing or poor food quality. Chlorophyll *a* alone cannot distinguish between predation and food quality. Figure D1B and accompanying text in Appendix D, bottom page 4, states this problem: "(s)pecifically, low chlorophyll *a* concentrations are found in both Better/Best and Poor/Worst conditions, but they represent very different food quality conditions for mesozooplankton."
2. The Bay Program needs to re-evaluate the basis of the chlorophyll *a* criterion.The determination of chlorophyll *a* thresholds using mesozooplankton abundances based on statistical analysis of field data are likely to have huge errors due to the effects of turbulent mixing on trophic interactions and relationships between food concentration, ingestion, assimilation, growth, and abundance under natural conditions. Error bars should be calculated and presented in the figures and tables.
3. Chlorophyll *a* is also an indication of organic matter and will effect DO concentrations. It seems unwise to develop chlorophyll *a* criteria independent of DO. What does the Bay Model say about DO levels using the chlorophyll *a* criterion based on zooplankton grazing?
4. There are no consistent data in the report to support the idea that increased chlorophyll *a* concentrations, per se, leads to increased detrimental phytoplankton species (Figure V-3 through 5, Plate C and D).
5. There is concern that the criterion calculated would not be protective of other taxa including SAV and/or other benthic communities. Clearly chlorophyll *a* has a shading effect in addition to its nutritional quality for zooplankton. As mentioned

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in Chapter IV comments earlier, there needs to be better integration between the water clarity and chlorophyll criteria.

6. Chlorophyll *a* concentrations between 20-30 μg liter^{-1} (Table V-10 and Appendix C) are quite high and needs to be clarified as maximum levels. If these concentrations are found in the open water, the SAV will not be protected in adjacent shallow water in any salinity gradient. It may be that the resulting *median* chlorophyll *a* value is protective of SAV in the shallow areas, but this hypothesis is not explained.
7. The chlorophyll *a* criterion for the polyhaline region (15 μg liter^{-1}, Table V-10) is virtually identical to the 95th percentile for the Chesapeake Bay Reference Phytoplankton Community (last column Figure V-8) suggesting that there is no need for improvement in that region. Is that the CBP belief?

RECOMMENDED CHANGES for Chlorophyll *a* Criterion

1. Link chlorophyll *a* to water clarity and DO by using chlorophyll *a* concentration to indicate poor water clarity and where low DO **may** evolve.
2. Figures V-6 through V-12 may be able to address mesozooplankton impairment with high chlorophyll *a* concentrations, if verified by controlled experiments. In addition, it may be possible to identify particular phytoplankton indicator species. However, the field data in Appendix D has too much scatter to do so at present.
3. The chlorophyll criterion development suffers from too many assumptions and is unnecessarily complex. A much more straightforward and useful approach would be to develop seasonal mean chlorophyll *a* and DO concentrations in different regions of the Bay using the existing extensive monitoring data. Measurements that deviate from the mean and are outside selected levels of probability can then be determined. Inter-annual trends in such deviations will be much more useful indicators of the efficacy of management actions and whether the Bay is "getting better" or "getting worse." For more information on this procedure please review the "climatologies" developed by physical oceanographers and meteorologists to study climate change. The web has many sites that can be easily accessed.

Chapter VI *Recommended Implementation Procedures.*

1. The approach does not account for patchiness of low DO with a large patch of DO equal to the sum of several smaller patches that add up to the same volume. The biological effects are likely quite different between these scenarios and are not considered.
2. The reference curve evaluation (Figure VI-3) is the basis of this approach and will likely face strong scrutiny because they require statistics and interpolation that are always open to interpretation. Are there scientifically defensible approaches to withstand possible litigation?

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3. The uncertainty discussed on page 7 will likely be quite large depending on the software used. The Bay Program should summarize the algorithms used and why it chose the particular analytical package.
4. The logistical regression approach (page 10 and Appendix F) is beyond the capabilities of the STAC reviewers and should be reviewed by a statistician.

Appendix A. ***Refined designated uses for the Chesapeake Bay and Tidal Tributaries.***

1. The selection of specific 'target species' should be re-examined since they were determined in 1987. Are they all still relevant? For restoration goals in Tampa Bay, 30 target species and 10 faunal "guilds" based on habitat requirements of target and other species were selected and have proved useful.
2. Maintaining targeted pH in the tributary tidal freshwater should be emphasized more. In the draft version, pH is only listed on page 3. It is clearly an important criterion for many important juvenile stages and eggs of targeted species.
3. The distinction between spawning/nursery grounds and shallow water designated uses is superfluous to many nursery species that spend part of their time in other habitats. Are these species properly protected in their transit from nursery to shallow waters under these designated uses?
4. While the designated use definitions are well defined, what seems to be missing is a procedure for resolving conflicts among designated uses such as between the open water and shallow water uses. If the open water criterion is not met, then it will likely not be met over the shallow water either. One possible remedy is a statement to the effect that shallow water clarity criteria also apply to the adjacent open water during the SAV growing season.
5. Management goals for SAV will require extensive time and money. Are the goals feasible given the trends in the Chesapeake Bay? Has there been a risk analysis or probability of success analysis done to determine the feasibility of the goals?

Reviewers' comments from other sections.

Appendix F ***Logistical Regression and Spectral Analysis Approaches to Defining DO Criteria Attainment.***

There is no background or justification given for this appendix. It cannot be properly reviewed without it.

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